International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 6, Issue 6, pp 63-67, June-2022
https://doi.org/10.47001/IRJIET/2022.606009

Effect of Helical Intake Manifold on the Performance of 4-Stroke Gasoline Engine

[1]Pujianto Aristiawan, [2]*Khoiri Rozi, [3]Berkah Fajar T.K.

[1,2,3]Mechanical Engineering, Diponegoro University, Semarang, Indonesia
Jl. Prof. H. Soedarto, SH, Tembalang-Semarang 50275, Tel. +62247460059
*Corresponding Author Email: khoiri.rozi@yahoo.com

***Abstract* – This investigation is conducted to study the characteristic of the helical intake manifold for the 4-stroke gasoline engine. The helical port geometry for this intake manifold is designed to get a more homogeneous mixture in the engine in which this can be done by making swirling flow from the end of the intake port. In addition, the helical port also has a positive impact on the engine performance. From this study, it is found that the helical port left is more dominant in the performance of torque, power, combustion ratio), air fuel ratio, volumetric and thermal efficiency. However, the lowest emission level for this experiment is produced by helical port right.**

Keywords: intake manifold, helical port, swirling, emissions, performance.

I. INTRODUCTION

The performance of gasoline engines are affected by the results of combustion in the cylinder chamber. Complete combustion will indicate optimal performance and exhaust emissions, as well as factors that affect the AFR ratio (fuel-air ratio), homogeneity of the fuel and air mixture, combustion time, optimal compression, engine quality, and operating conditions. optimal.To get a more homogeneous mixture of air and fuel in the engine, it can be done by making a rotating flow from the end of the intake manifold [1].

The main function this device is to circulate combustion air into the cylinders. In particular, the main design goal was to distribute it evenly to each intake port, increasing the engine's ability to generate torque and power efficiently. The geometric design of the intake system affects the volumetric efficiency of the engine, and directly affects the performance of the vehicle [2].

The intake system construction has a major influence on engine performance at various RPMs [3]. Therefore, the challenge was to optimize the intake system design and redesign the fuel injection system. So that the fuel and air that pass through the intake manifold form a rotating flow and become more homogeneous. So, to form a swirling flow in the intake manifold, a helical port mechanism is required.

The working principle of the helical port is the air flow that enters the combustion chamber is made to rotate, which leads to one point to help the combustion process become more complete. One of the parameters that affect the flow in the cylinder is the intake port design [4]. This mechanism is located in the cylinder head near the valve, where during the flow process from the intake to the combustion chamber there is a more perfect vortex change, so that the fuel and air mixture becomes more homogeneous [5].

Many studies related to helical angles have been carried out both experimentally and numerical simulations. Several parameters have been tested, but need to be improvised and re-examined to improve engine performance. This study will examine the flow at the intake manifold using the experimental method. This research was conducted by varying the tangential port, 30^o right angle helical port, and 30^0 left angle helical port.

Rotating flow serves to create an internal recirculation zone where there is the application of spiral motion to a flow, and forms a vortex that occurs on the core axis [6]. To improve air-fuel mixing and help spread the flame during combustion [7]. David et.al [8] studied numerically and experimentally about swirling flow in a helical port design for various operating conditions. The results of the study show that the helical design can increase the vortex/swirling which can improve engine performance, and minimize exhaust emissions. Ravi et. al [9] simulated a helical manifold design to increase volumetric efficiency. The results of his research showed an increase in volumetric efficiency at a pressure of 220 bar and 240 bar.Bassiony et.al [10] tested experimentally on increasing the turbulence intensity of the combustion mixture quality, using a spiral-helix shape of three helical diameters (1D, 2D, 3D; where D is the manifold inside diameter), and three port outlet angles of 0°, 30°, and 60°. The results of his research found that the 30o helical port angle can carry out fuel consumption, and exhaust emissions. Ceviz [11] studied experimentally on engine performance characteristics such as torque, power, thermal efficiency and fuel consumption specific to the length of the intake plenum. The results of the study show that variations in the length of the

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 6, Issue 6, pp 63-67, June-2022

https://doi.org/10.47001/IRJIET/2022.606009

plenum lead to an increase in engine performance characteristics, especially fuel consumption at high loads.

II. EXPERIMENTAL DEVICE

2.1 Model test

In this experimental study, the intake manifold test model uses three geometries, namely the tangential port, helical port right and helical port left as shown in Figure 1. The medium used is a 4 stroke 1 cylinder 110 CC petrol engine. Using pertalite fuel (RON 90), Pertamax (RON 92), and Pertamax turbo (RON 98). To look for changes in engine performance and exhaust emissions on torque, power, CO_2, CO, HC, O_2, Combustion Ratio (λ), Air Fuel Ratio (AFR), Volume Efficiency, and Thermal Efficiency. At engine speed of 2000 RPM to 8000 RPM, with a research range of 500 RPM, and load testing is carried out at 1 kW to 6 kW. The geometry information intake is shown in Table 1.

(a) (b)

Figure 1: Helical port intake test model (a) intake port left; (b) intake port right

Table 1: Geometry Intake Manifold

Parameters	Value
Intakediameter	22 mm
Intakevalve diameter	25,5 mm
Valvestem diameter	5 mm
Helicangle	30°
Bore	50 mm
Stroke	55 mm

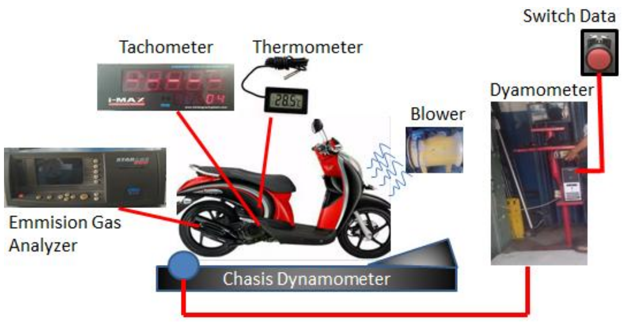


Figure 2: Experimental Setup of the Test Engine

2.2 Engine equipment

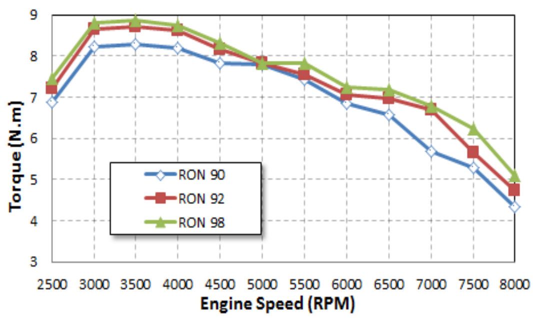
The experimental device shown in Figure 2 consists of a chassis dynamometer, gas emission analyzer, blower, tachometer, and anemometer. With the following machine specifications: Engine specifications in this test are as follows:

Engine type : 4 stroke, SOHC, 2 valves.
Carburetor : VK22x1.
Cylinder Volume : 108 CC.
Compression Ratio: 9.2:1 (new).
Number of Cylinders: 1.
Max Power: 6.09 kW/8.000 rpm (New).
Max Torque: 8.32 N.m/5500 rpm (New)

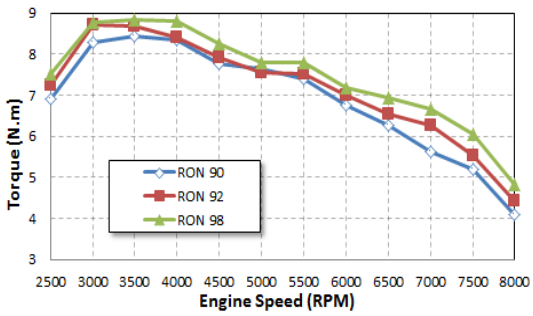
III. RESULTS AND DISCUSSIONS

3.1 Torque Characteristics (Nm)

The results of measuring torque as a function of engine speed are presented in Figure 3(a) and 3(b). Based on Figure 3(a) it can be seen that RON 98 fuel produces the highest torque of 8.86 N.m at 3500 RPM, 6.74% higher than RON 90.Then from Figure 3(b), it can be found that RON 98 produces the highest torque of 8.84 N.m at 3500 RPM or an increase of 4.61% when compared to the lowest variable.



(a)



(b)

Figure 3: Performance of helical pot right as function of engine speed (a) helical port left; (b) helical port right

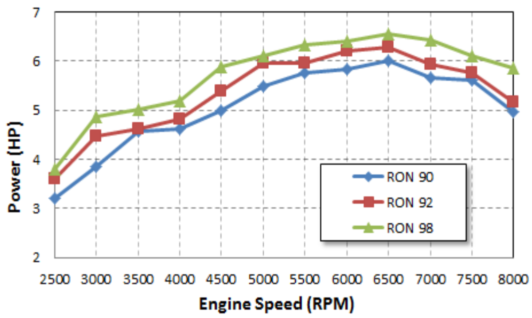
3.2 Power (HP)

The results of the power test on the engine speed (RPM) functions for helical port left dan port right are shown in Figure 4(a) and 4(b), respectively. Based on plot in the Figure

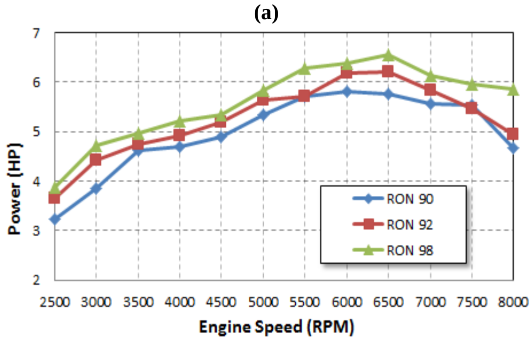
International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 6, Issue 6, pp 63-67, June-2022
https://doi.org/10.47001/IRJIET/2022.606009

4(a), it shows that RON 98 produces the highest power of 6.56 HP at 6500 RPM, 9.33% higher than RON 90.Meanwhile, based on the plot in Figure 4 (b) it shows that RON 98 produces the highest power of 6.55 HP at 6500 RPM or an increase of 13.71% when compared to the lowest variable.

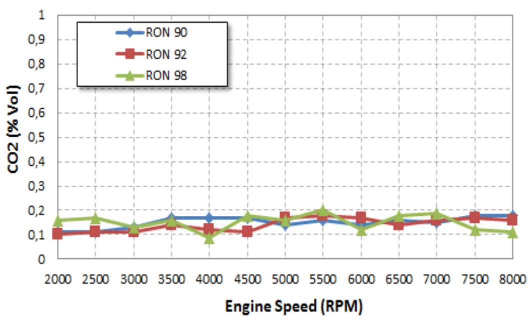


(a)

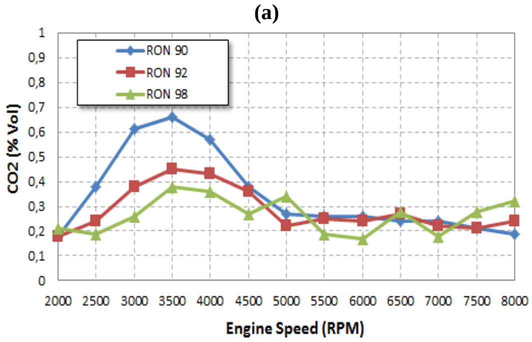


(b)

Figure 4: Performance of helical pot right as function of engine speed (a) helical port left; (b) helical port right



(a)



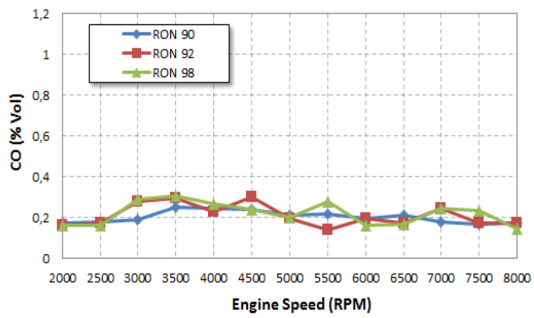
(b)

Figure 5: Emission of CO_2 as function of engine speed (a) helical port left; (b) helical port right

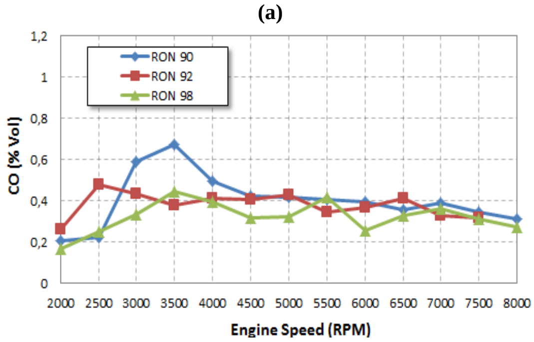
3.3 Emission of CO_2 and CO

The results of exhaust emissions for the intake manifold port left and port right against the engine rotation speed RPM) are presented in Figure 5(a) and 5(b), respectively. The result of CO_2 emission is presented in Figure 5 (a), from this plot it can be seen that RON 98 produces the lowest CO_2 at 0.09 % vol at 4000 RPM, 47.05 % lower than RON 90. However, for RON 92 has a more stable CO_2 emission level. From plot in Figure 5(b), it can be found that RON 98 produces the lowest and stable CO_2 content of 0.17 % vol at 6000 RPM or a decrease of 34.61%.

The results of CO emission as a function of engine speed for intake manifold port left and port right are shown in Figure 6(a) and 6(b), respectively. Based on plot in From Figure 6(a), it is known that RON 92 produces the lowest emission of 0.139 % vol at 5500 RPM engine speed or a decrease of 9.33% compared to the highest result. Then, from the plot in Figure 6(b) it is seen that RON 98 produces the lowest CO emission of 0.165% vol at 2000 RPM rotation or a decrease of 20.28% when compared to the highest variable.



(a)



(b)

Figure 6: Emission of CO as function of engine speed (a) helical port left; (b) helical port right

3.4 Combustion ratio

The results of the combustion ratio as a function of engine speed for the intake manifold port left and port right are shown in Figures 7(a) and 7(b), respectively. From the plot in Figure 7(a), it can be seen that the use of RON 98 (first turbo) fuel produces the most ideal combustion at various engine speed

ISSN (online): 2581-3048
Volume 6, Issue 6, pp 63-67, June-2022
https://doi.org/10.47001/IRJIET/2022.606009

conditions. Then, based on the plot in From Figure 7(b) it can be found that the fuel of Pertamax Turbo with RON 98 produces the most ideal combustion at various engine speed conditions.

3.5 Air fuel ratio (AFR)

The results of the air fuel ratio as a function of engine speed for the intake manifold port left and port right are presented in Figure 8(a) and 8(b), respectively. In the plot of Figure 8(a), it is shown that in the intake port left, RON 98 has a stable yield of combustion at various engine speed conditions. The similar result can be seen In Figure 8(b) for the intake manifold port right.

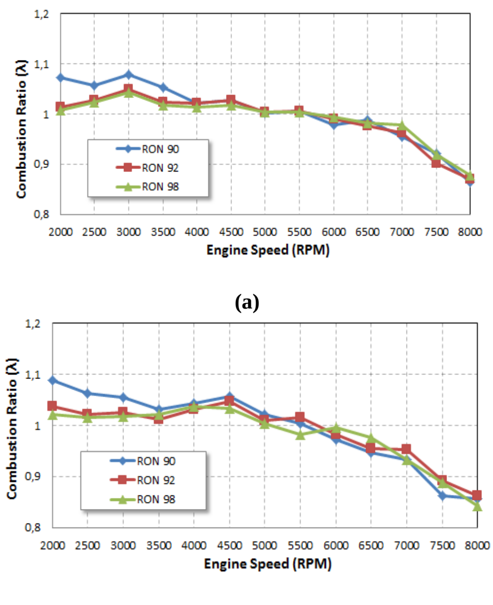


Figure 7: Air Fuel Ratio as function of engine speed (a) helical port left; (b) helical port right

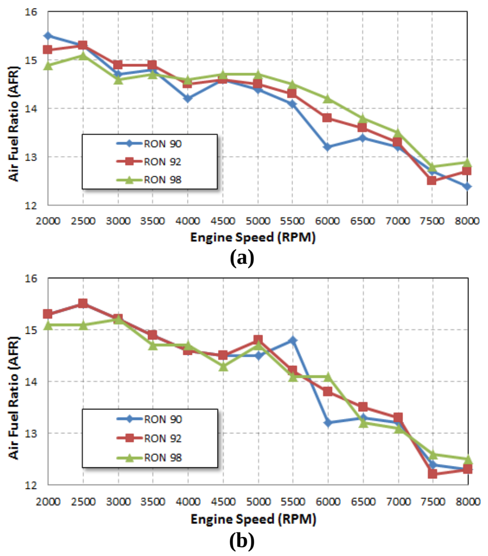


Figure 8: Air fuel ratio as function of engine speed (a) helical port left; (b) helical port right

3.6 Volumetric Efficiency

The calculating results of the volume efficiency for the helical intake manifold port left and port right with respect to engine speed (RPM) are shown in Figures 9(a) and 9(b), respectively. The plot of the volume efficiency in Figure 9 (a) explains that RON 98 produces the highest efficiency value of 95.5% at 6000 RPM, an increase of 6.74% when compared to RON 90. Meanwhile, for intake manifold port right as shown in Figure 9(b), it explains that RON 98 produces RON 98 produces the highest efficiency value of 92.8% at 6000 RPM, an increase of 9.30% when compared to RON 90.

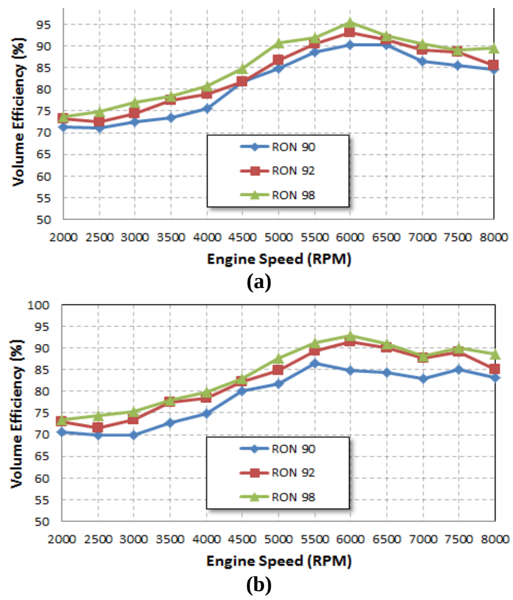


Figure 9: Volumetric efficiency as function of engine speed (a) helical port left; (b) helical port right

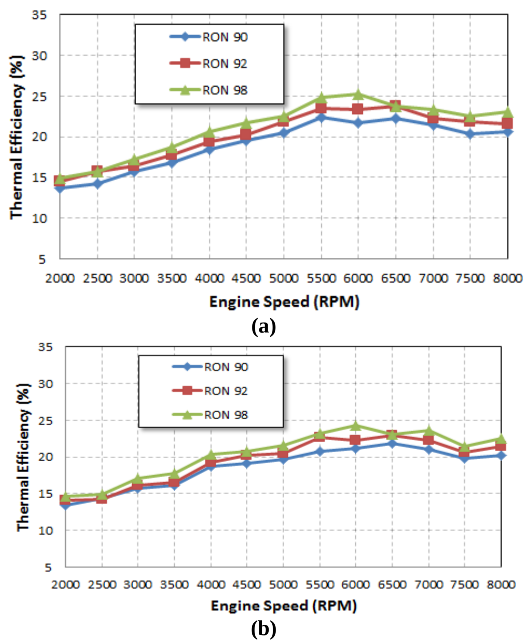


Figure 10: Thermal efficiency as function of engine speed (a) helical port left; (b) helical port right

ISSN (online): 2581-3048
Volume 6, Issue 6, pp 63-67, June-2022
https://doi.org/10.47001/IRJIET/2022.606009

3.7 Thermal Efficiency

The results of the thermal efficiency as a function of engine speed for intake manifold port left and port right are shown in Figure 10(a) and 10(b), respectively. Based on plot in Figure 10(a) for intake port left, it is known that RON 98 produces the highest thermal efficiency of 25.2% at 6000 RPM, 16.12% lower when compared to RON 90. Then, plot in Figure 10(b) for intake manifold port right, it is known that RON 98 produces the highest thermal value of 24.3% at 6000 RPM or an increase of 14.62%.

IV. CONCLUSION

Based on the results of the research that has been done, some conclusions can be drawn as follows:

1. The highest torque value is produced by the helical port left of 8.86 N.m at 3500 RPM, an increase of 6.74% and the highest power is 6.56 HP at 6500 RPM, an increase of 9.33% using RON fuel 98.
2. Results of exhaust emissions show that the lowest CO_2 value is generated by the intake type tangential port of 0.35 % vol at 3500 RPM or decreased by 43.64%, and the helical port right succeeded in reducing CO emission levels of 0.139% vol at engine speed of 5500 RPM or decreased by 9.33%. As well as the best combustion ratio (λ) and air fuel ratio (AFR) produced by the helical port left intake type using RON 98.
3. Based on the volumetric and thermal efficiency it shows the helical port left produces the most optimal efficiency value for a 4 stroke 1 cylinder gasoline engine.

ACKNOWLEDGEMENT

I would like to thank for RINUT MOTOR SEMARANG in helping to conduct this research and collecting all this experiment data.

REFERENCES

[1] Zhang, W., Chen, Z., Duan, Q., & Jiang, Q. (2021). Visual test and evolutionary analysis of flow fields in cylinder of helical intake port diesel engine. Energy, 223, 119926.

[2] Souza, G. R., Pellegrini, C., Ferreira, S., Felipe, S. P., Armas, O. (2018). Study of Intake Manifolds of an Internal Combustion Engine: A New Geometry Based on Experimental Results and Numerical Simulations, Elsevier: Thermal Science and Engineering Progress.

[3] Manmadhachary, A., Santosh Kumar, M., & Ravi Kumar, Y. (2017). Design & manufacturing of spiral intake manifold to improve volummetric efficiency of injection diesel engine by AM process. Materials Today: Proceedings, 4(2), 1084–1090

[4] Cui, L., Wang, T., Lu, Z., Jia, M., & Sun, Y. (2015). Full-Parameter Approach for the Intake Port Design of a Four-Valve Direct-Injection Gasoline Engine. Journal of Engineering for Gas Turbines and Power, 137(9), 091502.

[5] Wahono, B., Setiawan, A., & Lim, O. (2021). Effect of the intake port flow direction on the stability and characteristics of the in-cylinder flow field of a small motorcycle engine. Applied Energy, 288, 116659.

[6] Seshadri S. (2015). Design and CFD Analysis of the Intake Manifold for the Honda CBR250RR Engine. University Of Texas at Arlington.

[7] Wang, G., Yu, W., Li, X., Su, Y., Yang, R., & Wu, W. (2019). Study on dynamic characteristics of intake system and combustion of controllable intake swirl diesel engine. Energy, 180, 1008–1018.

[8] David, R., J. and Kumar, T., M., R. (2008). Studies on Variable Swirl Intake System for Di Diesel Engine Using Computational Fluid Dynamic. Thermal Science. Vol 12 No.1 pp.25-32.

[9] Ravi, S., Rahul, B., Basil, S., Vijay, V. (2018). Design and Simulation of Helical Intake Manifold. International Journal of Research in Engineering, Science and Management. Volume-1, Issue-10.

[10] Bassiony MA, Sadiq AM, Gergawy MT, Ahmed SF, Ghani S (2018). Investigating the effect of utilizing new induction manifold designs on the combustion characteristics and emissions of a DI diesel engine. J Energy Res Technol 2018; 140 (12):122202–17.

[11] Ceviz, M. A., & Akın, M. (2010). Design of a new SI engine intake manifold with variable length plenum. Energy Conversion and Management, 51(11), 2239–2244.

Citation of this Article:

Pujianto Aristiawan, Khoiri Rozi, Berkah Fajar T.K., "Effect of Helical Intake Manifold on the Performance of 4-Stroke Gasoline Engine" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 6, pp 63-67, June 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.606009

****

